Does female employment reduce fertility rates?
Evidence from the Senegalese horticultural export sector

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Abstract

The recent horticultural export boom in Senegal has created new off-farm wage employment opportunities for the rural population, especially for women. We hypothesise that female wage employment may lower fertility rates through an income effect, an empowerment effect and a substitution effect, and address this question empirically using household survey data and two different regression techniques (a Difference-in-Differences estimator and an Instrumental Variable approach). We find that besides education, female employment has a significant negative effect on fertility rates. Reducing fertility rates is considered as a prerequisite for reaching the MDGs, and our finding implies that the horticultural export boom and associated employment may indirectly contribute to this.

KEYWORDS: horticultural export, female labour market participation, female empowerment, fertility rate, Senegal

Introduction

Horticultural exports from developing countries have increased tremendously in the past two decades (Maertens et al., 2012). The rise in global high-value food supply chains has been accompanied by vertical integration and increased agricultural wage employment, creating significant welfare improvements for the rural population in poor countries (Swinnen, 2007; Gomez et al., 2011). Most studies have focussed on the direct income and poverty effects of employment in export chains (Maertens and Swinnen, 2009; Neven et al., 2009; Maertens et al., 2011; Rao and Qaim, 2013). Yet, few studies investigate indirect effects on local development, which emerge through different mechanisms. Exceptions include Maertens (2009), who finds that wages earned in the horticultural export industry in Senegal are partially invested in the household's own farm business, leading to improved agricultural productivity. Dolan and Sutherland (2002), Barrientos et al. (2003) and Maertens and Swinnen (2012) observe that mostly women are employed in horticultural export chains in Sub-Saharan Africa (SSA), suggesting the possibility of female empowerment. Maertens and Verhofstadt (2013) find that female wage employment has a positive impact on primary school enrolment in Senegal.

In this paper, we analyse the impact of female wage employment on fertility rates. We investigate a case study in Senegal, where during the last decade the horticultural export has boomed and has tremendously increased off-farm employment opportunities for rural women. While the relationship between women's employment status and fertility rate has been thoroughly documented for industrialised countries (Brewster and Rindfuss, 2000; Kalwij, 2000; Ahn and Mira, 2002), it is a fairly unexplored issue for developing countries. Exceptions include Fang et al. (2013) and Beguy (2009) who analyse the impact of female employment on fertility in rural China, and urban Senegal and Togo.

Our research question is relevant, because reducing fertility rate is often proposed as a strategy to empower women and eradicate poverty (Cleland et al., 2006). Family planning benefits both the health of mother and children, but also the household's economic status. First, contraceptive use prevents high-risk pregnancies, thereby reducing maternal and child mortality rate (Cleland et al., 2012). High risks are associated with pregnancies at very young maternal ages, women at high parities, and pregnancies that would have ended in unsafe abortion. Contraceptives can be used to space births, which can further benefit the health of mothers and children. Second, if the number of children is reduced, women have more time available for other activities besides reproductive tasks, which creates opportunities for gaining extra income (Canning and Schultz, 2012). Third, parents can spend more money and time per child on nutrition, education, and health, or they can decide to invest more in assets, businesses, and savings when they have fewer children (Canning and Schultz, 2012). The overall effect is the improvement of households' welfare. In general, decreasing the number of children per woman helps reaching the Millennium Development Goals (MDGs), by reducing poverty and hunger, empowering women, and improving child and maternal health.

Despite the demonstrated benefits of reduced fertility rates, the number of children per woman remains very high in developing countries. In Senegal, the total fertility rate was 4.8 in 2010, ranking Senegal on the 26th place of highest fertility rates in the world (UNICEF, 2012). The main reasons for a high number of children are diverse. A high fertility rate is a survival strategy to cope with a high infant mortality rate. In countries where public or private pension systems lack, parents need many children in order to support them at old age. Religion often plays an important role in traditional, rural settings, forbidding the use of any modern family planning method. Even when people would like to limit their number of children, very often a lack of knowledge about modern birth control methods prevails in poor, rural areas. Finally, the access to contraceptives is crucial for family planning. In Senegal, only 13% of the fertile, married women uses contraception. The government has taken initiative to increase the country's contraceptive prevalence rate to 27% by 2015, by enhancing knowledge about family planning, especially in rural areas, and improving supply of contraceptives (République du Sénégal, 2012).

Family planning programs that focus on the supply side of contraceptives are necessary, but they do not suffice to reduce fertility rates. As long as preferences for a high number of children prevail, it is unlikely that total fertility rates will decrease. A mechanism to alter fertility rate preference is female employment status, which affects the number of children through various channels. First, households' total income increases when women are wage employed, resulting in an income effect. According to the quality/quantity trade-off theory, the effect on fertility rates might be positive or negative, depending on couples' preferences for either quantity, i.e. number of children, or quality of child care (Becker, 1960). If quality of child care improves, such as food, schooling and health expenditures, the cost of an additional child increases as well. Generally, the income level is negatively correlated with fertility rates (Canning and Schultz, 2012). Second, women who earn their own income are likely to have a higher say in household decisions than women who depend economically entirely on their husbands. If women's bargaining power within the household increases, and they prefer fewer children than men, fertility rates will decrease. According to Upadhay and Karasek (2010), men's ideal number of children in SSA tends to be higher than women's, suggesting a reduction in fertility rates if women are empowered. Third, if women are wage employed, the opportunity cost of raising children increases. This substitution effect results in a decrease in the number of children. In summary, we distinguish three different channels through which female employment affects fertility rate: an income effect, a female empowerment effect, and a substitution effect.

Estimating the causal impact of female wage employment on fertility rates is not straightforward, because employment is probably endogenous. Two sources of endogeneity may lead to an under- or overestimation of the impact: omitted variable bias and reversed causality. First, social norms and values in a traditional, rural setting such as in our case study, might prevent that women participate in the wage labour market. Unobservable characteristics, such as the bargaining power of women before they are employed, influence whether they are allowed to participate in the labour market or not (Basu, 2006). We cannot observe initial bargaining power directly, while this is probably also correlated with fertility rates. Second, female employment status has an effect on fertility rates, but the presence of children might also determine whether a woman is able to participate in the labour market or not. Since long this reversed causality has been recognised in the literature (Cramer, 1980). To tackle the endogeneity problem, we apply two different regression techniques involving a Difference-in-Differences estimator and an Instrumental Variable approach. We use the establishment of horticultural export companies as an exogenous source of variation in female wage employment that affects fertility outcomes only through individual employment decisions.

Our results indicate that female wage employment has a negative impact on fertility. The effect is quite large; the reduction in number of children ranges from 0.22 to 0.36. Moreover, our results suggest that the effect of female wage employment on fertility rates is not endogenous. Besides employment, we find that other factors determine fertility as well, such as women's literacy level and households' welfare.

This paper is structured as follows. First, the research area and data collection methods are presented. Second, we describe the growth of horticultural exports, its associated increase in female employment, and some fertility indicators. Third, we use econometric models to analyse the impact of female wage employment on fertility rates. The final section concludes and gives implications of our research.

Data collection

We collected survey data in 2013 in the Saint-Louis region, close to the Senegal river delta in the north-western part of Senegal. The area is an important horticultural export region where currently five export companies are located. We used a stratified random sampling strategy, resulting in the selection of 500 households in 34 villages over three rural communities. The survey provides general data on household crop and livestock production, land assets and living conditions, while socio-economic characteristics, employment (in horticultural companies) and other off-farm income sources were asked at individual level. The data allow us to calculate for each household member separately the income generated from employment in the horticultural export sector or from other sectors, and from self-employment. Specifically important for the analysis in this paper is that we know the number of children of all women between 18 and 40 years old, and the age of the children. In this way we are able to reconstruct for each woman a detailed fertility history. The resulting sample consists of 997 women in total, of which 185 are wage employed (66% of them in the horticultural export sector). Additional data were collected at village level, providing information about the presence of female organizations and distances to concrete roads or horticultural companies. Furthermore, we conducted interviews with the five horticultural companies on production activities, sourcing strategies and working conditions.

Horticultural export, female wage employment and fertility

The horticultural export from Senegal has boomed enormously during the last decade (Figure 1). Tomatoes, the main export crop, are principally sourced from the Senegal river delta. A first horticultural export company, a subsidiary of a large multinational holding, invested in this area in 2003 and started to export cherry tomatoes to the European Union (EU) in 2005. Since then the number of horticultural exporters in the region has increased to five, and the cultivated area and produce variety are still expanding. These export companies all rely completely on a vertically integrated production system with primary production organised by the export company on land that is leased from the rural communities and the government. The boom in horticultural exports from the Senegal river delta region has created approximately 5000 jobs of which 80% are occupied by women. Most of the export companies are engaged in rural development programs, by providing health care services, supporting local schools or improving access to water. The employees come from the surrounding villages and traditionally diversify their income through crop and livestock production, and (self-) employment in small entrepreneur businesses.

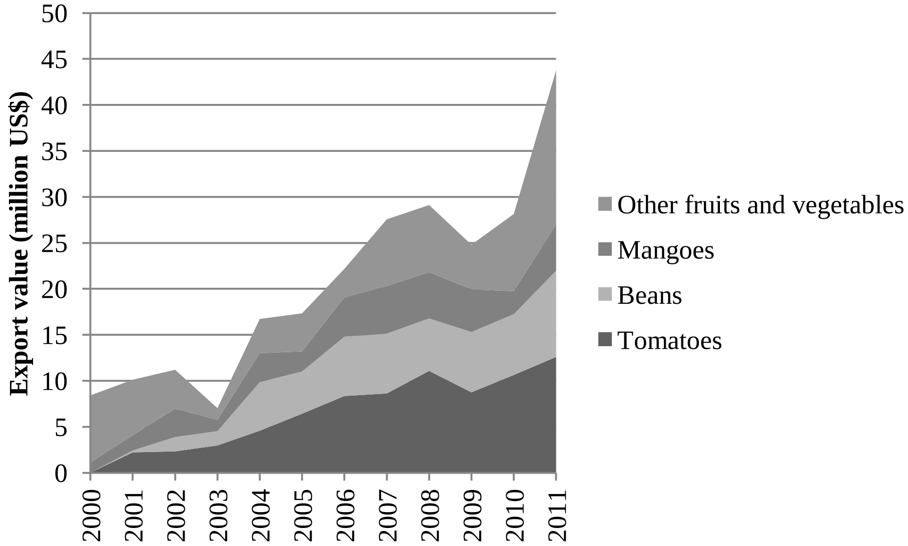

Figure 1. Exports of fruit and vegetables from Senegal, 2000-2011. ***Source*****: FAOSTAT.**

The increase in horticultural exports is associated with an increase in female wage employment (Figure 2). Especially since the start of horticultural exports in 2005, the share of wage employed women has increased sharply. In the region north of Saint-Louis, where the five export companies are located, only 5% of women were wage employed in 2005 while in 2013 this number has increased to more than 20%. The female workers are involved in harvest, transformation and packing activities, including permanent as well as seasonal and day-to-day employment. Besides the horticultural export sector, women can be employed as domestic worker, hairdresser or tailor, mostly in Saint-Louis. However, these employment opportunities are scarce as most women do not participate in the labour market in rural Senegal. Instead they are responsible for reproductive tasks, such as taking care of the children, cooking and doing laundry, and working on the family farm.

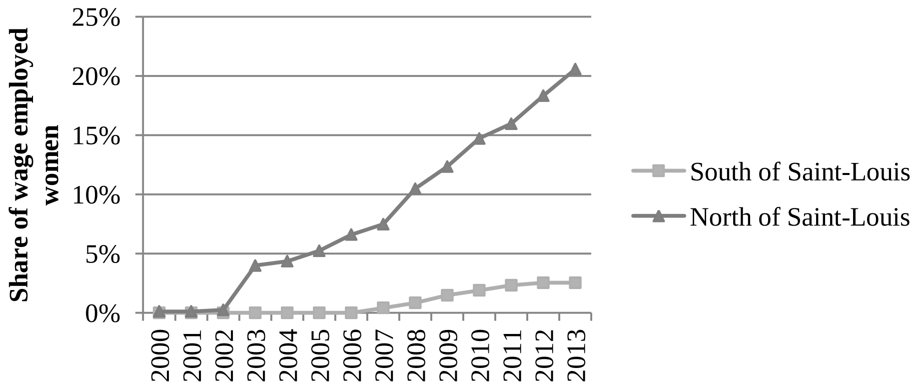

Figure 2. Share of women who are wage employed in horticultural export sector over time. ***Source*****: Own calculations from survey data.**

The wages of employed women contribute importantly to total household income (Table 1). Households with female employment have significantly higher total incomes, and the income from female employment represents 37% of the total income of these households. In households with female employment, the share of female income is comparable to male income, while for households without female employment the share of male income is 6 times higher. This difference is huge and is likely to have an impact on the empowerment of women. Furthermore, we notice that the horticultural export sector is the most important source of employment for women in our research area.

Table 1. Household income from different sources across households with and without female wage employment. *Source*: own calculations from survey data.

	Total	Households without female wage employment	Households with female wage employment	t-test
Number of observations	500	368	132	
Total household income (FCFA)	2,718,627	2,584,548	3,092,425	*
Average share of total household income from different sources				
Household agricultural income	29.78%	35.01%	15.31%	***
Household non-labour income	16.38%	18.57%	10.33%	***
Male income	37.50%	38.78%	33.98%	
Employment in horticultural export	7.97%	6.38%	12.39%	***
Employment in other sectors	6.96%	6.90%	7.13%	
Self-employment	22.57%	25.50%	14.46%	***
Female income	14.50%	6.42%	36.85%	***
Employment in horticultural export	6.67%	0.00%	25.10%	***
Employment in other sectors	2.14%	0.00%	8.05%	***
Self-employment	5.70%	6.42%	3.70%	**

Comparisons are made between households with female wage employment and households without female wage employment using *t*-tests. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Before we econometrically analyse the impact of female wage employment on fertility rates, we calculate and describe some fertility indicators. In general, wage employed women have significantly fewer children than non-employed women (Figure 3). The average fertility rate of women between 18 and 40 is 1.4 for non-employed women and 1.1 for employed women. Age at marriage and maternal age strongly influence fertility as well (Figure 4). If women marry and get children at an older age, the window of biological opportunity for subsequent children will be narrower. We find in our sample that employed women are significantly less married or have children. When they do marry or get children, it occurs at an older age. These descriptive statistics confirm that wage employed women have fewer children, but they do not show that female wage employment has a causal effect on fertility rates. To assess this impact we turn to the econometric analysis.

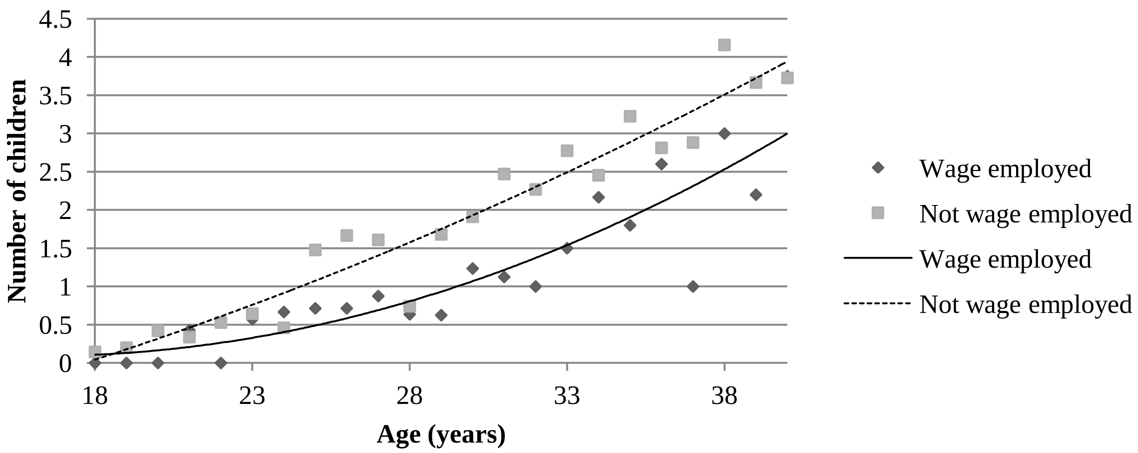

Figure 3. Number of children per woman over age by employment status. ***Source*****: Own calculations from survey data.**

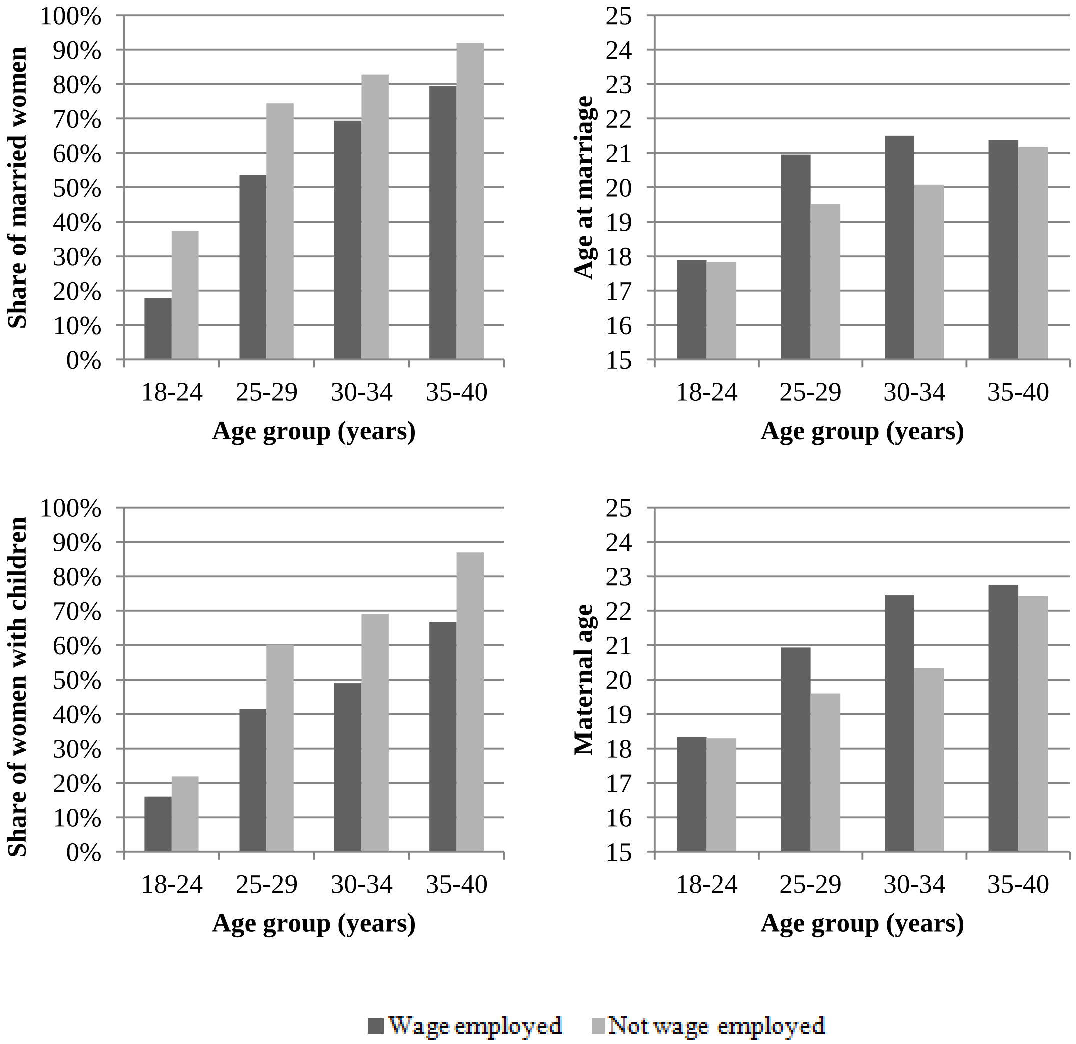

Figure 4. Fertility indicators over age group by employment status: a) Share of married women; b) Age at marriage; c) Share of women with children; d) Maternal age. ***Source*****: Own calculations form survey data.**

Econometric analysis

First empirical strategy: Difference-in-Differences

To estimate the impact of wage employment on fertility rates, we use two empirical strategies. The first strategy is based on a Difference-in-Differences (DD) estimator. This estimator relies on a comparison between treated and control units before and after the treatment. We note that the horticultural export boom and the associated creation of off-farm wage employment for women started since 2005. We use this exogenous shock as a treatment and calculate the number of children a woman has in 2005, i.e. the outcome variable before treatment, and the number of children in 2013, after treatment, and compare the difference between employed and unemployed women. In equation (1), the coefficient ϕ on the interaction between the treatment (T_i) and time (t) represents the DD effect of female wage employment on fertility rates. The variables T_i and t are separately included to control for effects that differ over time as well as the effect of being employed versus not being employed. The covariates X_{it} are relevant characteristics describing women's fertility behaviour that are available for both time periods, such as age, literacy, marital status, religion, ethnicity, land assets and distance to the nearest concrete road.

$$\boldsymbol{Y_{it} = \alpha + \phi T_i t + \rho T_i + \gamma t + \beta X_{it} + \varepsilon_{it}} \qquad (1)$$

The DD estimator is based on the assumption that unobserved heterogeneity is time invariant and uncorrelated with the treatment over time. In practice, however, this assumption is often violated as selection bias is probably not time invariant. Changes over time are influenced by initial conditions that likely also determine treatment status. One way to control for initial conditions is to match participants and nonparticipants on pre-treatment characteristics. We use Propensity Score Matching (PSM) to match observed characteristics of employed and unemployed women in 2005, and analyse the treatment impact across treated and control units within the common support. The same variables of X_{it} in equation (1) are used to calculate the propensity score.

In order to control for unobserved time-invariant heterogeneity we use a panel Fixed Effects (FE) model. By differencing both the left- and right-hand side of equation (1) over the two time periods, the unobserved time-invariant individual characteristics are dropped. By removing this potential source of endogeneity, ordinary least squares (OLS) can be applied to estimate the unbiased effect of female wage employment (ϕ), which is equivalent to the DD estimator.

$$\boldsymbol{\Delta Y_i = \phi \Delta T_i + \beta \Delta X_i + \Delta \varepsilon_i} \qquad (2)$$

Second empirical strategy: Instrumental Variable approach

The second empirical strategy involves the estimation of three models based on a Poisson distribution, because the dependent variable Y_i, number of children per woman, is a nonnegative integer.

$$\mathbf{Pr}(\boldsymbol{Y_i = y}) = \frac{e^{-\mu_i}\mu_i^{y}}{y!} \qquad (3)$$

The parameter μ_i represents the mean and variance of Y_i that we assume to be an exponential function of a vector of covariates X_i. In addition to the characteristics used in the DD approach, we are able to control for characteristics that are only available for 2013. The individual characteristics include link with the household head, and the household characteristics include the age, gender and literacy of the household head, livestock units and poverty status. The village characteristics include the presence of a female organisation, ethnic composition and the share of girls between 6 and 18 years old enrolled in school. These variables capture relevant peer and cross-over effects that likely determine fertility rate preferences at village level. Additionally, we include the number of children in 2005 to check whether female wage employment affects fertility rates when the number of children before the horticultural export boom started is taken into account. Our main variable of interest, female wage employment, is specified as a dummy.

$$\boldsymbol{\mu_i = e^{\beta X_i + u_i}} \tag{4}$$

We use three different econometric models to estimate equation (3). First, we estimate a standard Poisson regression with robust standard errors to correct for overdispersion. Second, we use village FE to control for unobserved village level characteristics that affect both fertility rates and the probability of a woman to be wage employed. Third, we apply a two-stage residual inclusion (2SRI) or control-function approach to further control for endogeneity. A conventional two-stage least squares (2SLS) approach would lead to inconsistent estimates, because of the non-linearity of the Poisson model (Terza et al., 2008). The procedure for a 2SRI follows two stages: in the first stage female wage employment is regressed on the exogenous covariates and an instrumental variable, and in the second stage the fertility rate is regressed on the observed values of employment, the exogenous covariates, and the predicted residuals from the first stage. We correct the standard errors that are underestimated in a two-stage approach by bootstrapping with 200 replications. If the predicted residuals are significant, the instrumented variable is endogenous. However, if they are insignificant, the coefficient estimate for the instrumented variable is consistent but will be less efficient than the estimate of the standard Poisson regression.

The 2SRI estimates are only consistent on the condition that the instrumental variable is valid, i.e. the instrument should be correlated to employment, and should affect fertility *only* through employment. As instrumental variable we propose the distance to the nearest horticultural export company, which is negatively correlated with the probability of being wage employed. As the establishment of the horticultural export companies can be seen as an exogenous shock, the distance to the nearest horticultural export company should be uncorrelated with u_i, the error term in equation (4).

Results and discussion

An overview of the different variables used in the analysis is given in Table 2. We observe significant differences between wage employed and non-wage employed women. Employed women are older, more of them are literate, more of them are single, and they are often daughters of the household head. The household heads of employed women are older, more of them are literate, and they own less livestock units. Households with wage employed women have a lower probability to be poor than households without wage employed women (although the difference is not significant), but the overall poverty rate remains quite high. Employed women live closer to the road and are more likely to live in a village with a female organisation and with a higher share of girls enrolled in school.

Table 2. Individual and household characteristics across employed and non-employed women. *Source*: own calculations from survey data.

Characteristics	Total		Not wage employed		Wage employed		
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	
Individual characteristics							
Age	26.79	6.51	26.39	6.51	28.57	6.21	***
Literacy	44.83%		42.98%		52.97%		***
Single	40.22%		38.55%		47.57%		**
Wife of HH head	21.46%		22.54%		16.76%		**
Daughter or granddaughter	43.03%		40.15%		55.68%		***
Household characteristics							
Religion (1 = christian)	3.01%		2.83%		3.78%		
Ethnicity (1 = Wolof)	48.75%		48.65%		49.19%		
Ethnicity (1 = Pular)	36.61%		37.68%		31.89%		*
Gender HH head (1 = female)	11.63%		11.21%		13.51%		
Age HH head	57.62	13.63	57.27	13.75	59.15	13.01	**
Literacy HH head	28.89%		26.48%		39.46%		***
Land owned (ha)	2.91	7.14	3.02	7.08	2.43	7.39	
Livestock units[a]	10.14	43.75	11.55	48.13	3.95	10.08	**
Poor Household (MPI>33)[b]	46.74%		47.41%		43.78%		
Village characteristics							
Female organisation in village	45.14%		41.26%		62.16%		***
Distance to road (km)	2.34	3.14	2.55	3.23	1.43	2.58	***
Multiple ethnicities in village	66.20%		65.64%		68.65%		
Share of girls enrolled in school	81.32%	15.12%	80.59%	15.64%	84.58%	12.06%	***
Number of observations	997		812		185		

Comparisons are made between wage employed women and non-wage employed women using *t*-tests. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.
[a] One tropical livestock unit (TLU) equals 1 cow/horse, 0.8 donkey, and 0.2 sheep/goat.
[b] The Multidimensional Poverty Index (MPI) is calculated according to the guidelines by the United Nations Development Programme (Alkire and Santos, 2010).

The average number of children for employed and non-employed women in 2005 and 2013 are presented in Table 3. While employed and non-employed women had on average the same number of children before the horticultural export boom started, in 2013 this difference becomes much more pronounced. According to the DD estimator, female wage employment reduces the number of children by 0.33 and this impact is significant at a less than 1% level.

Table 3. Number of children across employed and non-employed women before and after the horticultural export boom. *Source*: Own calculations from survey data.

	2005 (Before horticultural export boom)	2013 (After horticultural export boom)	Difference
Employed women	0.11 (0.39)	1.06 (1.61)	0.95 (1.42)
Non-employed women	0.12 (0.45)	1.40 (1.91)	1.28 (1.74)
		DD estimator	-0.33 ***

Standard deviations are reported in parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

We report the regression results of the DD approach and the Poisson based models in Appendix, in Table A 1 and Table A 2. The coefficients of the DD estimator and the average marginal effects of the Poisson based models for female wage employment are summarised in Table 4. Our main conclusion is that female wage employment has a negative effect on fertility rates. The six different models show quite similar magnitudes and significance levels of the effect, showing the robustness of our estimations. We find that female wage employment reduces the number of children, ranging from 0.22 to 0.36. If we compare this with the average fertility rate in our sample (1.34), then female wage employment reduces the number of children by at least 16%, which is a large and important effect.

Table 4. Summary of regression results on the impact of female wage employment on fertility rates. *Source*: own estimations from survey data.

	DD estimator (coefficients)			Poisson model (marginal effects)		
	OLS	OLS PSM	FE PSM	Poisson	Village FE	2SRI
Impact of wage employment	-0.291 **	-0.291 **	-0.361 ***	-0.257 **	-0.215 *	-0.262
(st.err.)	(0.122)	(0.122)	(0.137)	(0.109)	(0.125)	(0.553)

Significant effects are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01.

We notice that while the marginal effect of wage employment in the 2SRI is similar to the standard Poisson regression, the standard error is more than five times as large, which results in an insignificant effect. However, in Table A 2 the predicted residuals from the first stage are not significant in the second stage, indicating that female wage employment is not endogenous. Consequently, the 2SRI approach leads to a less efficient estimate than the standard Poisson regression. Another finding that indicates that female wage employment is not endogenous is the similar result of the Poisson and the Village FE model. Apparently, unobserved village characteristics are not jointly correlated with female wage employment and fertility rates, and thus we can assume that there is no omitted variable bias (at least at village level). Last, the insignificant effect of number of children in 2005 in the first stage in Table A 3, indicates that a woman's number of children before the horticultural export boom started, did not seem to influence the probability of being wage employed. This suggests that in our case-study there is no reversed causality.

Another key factor that determines fertility is education of women. Our results show that literacy reduces fertility rates by 0.25 children, which is the same magnitude as the effect of female wage employment. Osili and Long (2008) find that a one year increase in female education reduces fertility by 0.26 births in Nigeria, which is very comparable to our finding. In Table 5 we include an additional interaction term with employment and literacy in our regressions. We find that employment and literacy both have negative signs, while the interaction term is positive. This shows that the effect of employment on fertility rates is strongest for illiterate women, indicating that female wage employment might be a strong mechanism to empower uneducated women. Another related, indirect effect of female wage employment on education is shown by Maertens and Verhofstadt (2013). They find that female employment in the Senegalese horticultural export sector increases primary school enrolment rates, especially for girls. Thus, female employment not only affects directly fertility rates, but also indirectly by improving education of girls and consequently reducing their fertility rates. Besides creating employment opportunities for women, education remains a key strategy for female empowerment.

Table 5. Summary of regression results on the joint impact of female wage employment and literacy / poverty on fertility rates. ***Source*****: own estimations from survey data.**

	Poisson (1)			Poisson (2)	
Wage employment	-0.428	***	Wage employment	-0.295	*
	(0.140)			(0.160)	
Employed * Literacy	0.470	**	Employed * Poverty	0.065	
	(0.230)			(0.220)	
Literacy	-0.349	***	Poor household (MPI>33)	0.181	**
	(0.120)			(0.090)	
Other variables	Included		Other variables	Included	

Standard errors are reported in parentheses. Significant effects are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01.

Another main factor that is recognised to affect fertility is households' wealth or poverty level. We find a robust effect of poverty on fertility rates, indicating that if a household is poor, a woman's number of children is increased by 0.19. In Table 5, we follow the same approach as for literacy by including an additional interaction term with employment and poverty in our regressions. In contrast to literacy, the interaction term is not significant. We conclude that the effect of wage employment on fertility is equally strong for poor and non-poor women.

Other factors have an impact on fertility as well. First, the results of the individual specific characteristics are discussed. In line with our expectations, age has a positive but decreasing effect, indicating that younger women have a higher probability to get children. Marital status affects fertility as single women have fewer children than married, widowed or divorced women. The link with the household head matters as well. Daughters of the household head have fewer children while wives of the household head have more children.

Second, household level characteristics explain fertility further. We find that ethnicity does not have a significant effect on fertility rates, while religion does matter. Christian women have *ceteris paribus* fewer children than Muslim women. Women in female headed households have more children and the older the household head, the more children a woman has. The effect of the household head's literacy is insignificant. While a woman's individual education has a strong and robust effect on fertility rates, education of the household head does not seem to influence fertility, suggesting that schooling of especially young women is important in order to reduce fertility rates. Productive assets, such as land and livestock units, do not significantly affect fertility rates. This is a bit surprising as one might expect that households with more landholdings and livestock units need a higher (family) labour input. If children have to work on the family farm, a high number of children is preferred. In our research area, however, intensive child labour on family farms is not common, and therefore, land and livestock assets do not influence fertility rates. Another explanation might be that a countervailing wealth effect occurs. Richer households who have more assets put more weight on the quality than on the quantity of children, resulting in a net zero effect of assets on fertility rates. Finally, village level characteristics do not seem to significantly influence fertility rates in our sample. This is confirmed by the similar results of the Poisson and the village FE model.

We report the estimated coefficients of the first stage of the 2SRI approach in Table A 3. The instrument, distance to nearest horticultural export company, is significant at a less than 1% level and has an F-value of 27.59, confirming that the instrument is not weak (Stock et al., 2002). We find that age, being a (grand)daughter of the household head and living in a village with a female organisation have a positive influence on the probability of being employed, while Wolof ethnicity, being married, living further away from a concrete road or in a village with multiple ethnicities reduce the probability of employment.

Conclusion

By investigating a case study in Senegal, we find that female wage employment has a significant, negative impact on fertility rates. The effect is quite large: the reduction in number of children ranges from 0.22 to 0.36. Our findings have important implications for developing countries who adopt family planning programs to reduce rapid population growth. While these programs mainly focus on increasing awareness about modern family planning methods and improving access to contraceptives, the creation of off-farm employment opportunities for rural women turns out to be an additional key strategy to decrease fertility rates.

Besides female wage employment, we find other factors that determine fertility rates as well. Education of women remains crucial for female empowerment. However, we find that the effect of employment on fertility is strongest for illiterate women, suggesting that employment might be an empowerment mechanism for non-educated women. Households' wealth level also affects fertility, as a reduction in poverty is associated with a reduction in fertility.

While the impact of female wage employment on fertility has been thoroughly documented for industrialised countries, it is a fairly unexplored issue for developing countries, especially for SSA. This is surprising, as fertility rates in SSA are amongst the highest in the world. With our research, we have contributed to the development literature by investigating a relevant issue. However, we acknowledge that our results might be site-specific, so we recommend further research about the impact of female wage employment on fertility in developing countries in general, and in SSA specifically.

As the horticultural export sector represents the biggest source of off-farm wage employment for women in rural Senegal, the export boom has indirectly contributed to a reduction in fertility rates. More scientific studies are needed to assess the indirect effects of high-value exports from poor countries, as they can be important catalysts for development. Overall, decreasing fertility rates helps reaching the MDGs, by reducing poverty and hunger, empowering women, and improving child and maternal health.

References

Ahn, N. and Mira, P. (2002). A note on the changing relationship between fertility and female employment rates in developed countries. *Journal of Population Economics* 15: 667–682.

Alkire, S. and Santos, M.E. (2010). Acute Multidimensional Poverty: A new index for developing countries. United Nations Development Programme, Human Development Reports, Research Paper.

Barrientos, S., Dolan, C. and Tallontire, A. (2003). A gendered value chain approach to codes of conduct in African horticulture. *World Development* 31 (9): 1511-1526.

Basu, K. (2006). Gender and Say: a Model of Household Behaviour with Endogenously Determined Balance of Power. *Economic Journal* 116 (511): 558-580.

Becker, S. (1960). An Economic Analysis of Fertility. In: Demographic and economic change in developed countries. Universities-N.B.E.R. conference series No 11. Princeton University, Princeton.

Beguy, D. (2009). The impact of female employment on fertility in Dakar (Senegal) and Lomé (Togo). *Demographic Research* 20 (7): 97-128.

Brewster, K.L. and Rindfuss, R.R. (2000). Fertility and women's employment in industrialized nations. *Annual Review of Sociology* 26: 271-296.

Canning, D. and Schultz, P.T. (2012). The economic consequences of reproductive health and family planning. *Lancet* 380: 165-171.

Cleland, J., Bernstein, S., Ezeh, A., Faundes, A., Glasier, A. and Innis, J. (2006). Family planning: the unfinished agenda. *Lancet* 368: 1810-1827.

Cleland, J., Conde-Agudelo, A., Peterson, H., Ross, J. and Tsui, A. (2012). Contraception and health. *Lancet* 380: 149-156.

Cramer, J.C. (1980). Fertility and female employment: Problems of causal direction. *American Sociological Review* 45: 167-190.

Dolan, C. and Sutherland, K. (2002). Gender and employment in the Kenya horticulture value chain. Globalization and poverty discussion paper 8. University of East Anglia: Norwich.

Fang, H., Eggleston, K.N., Rizzo, J.A., and Zeckhauser, R.J. (2013). Jobs and kids: female employment and fertility in China. *IZA Journal of Labor & Development* 2:12.

Gómez, M.I., Barrett, C.B., Buck, L.E., De Groote, H., Ferris, S., Gao, H.O., McCullough, E., Miller, D.D., Outhred, H., Pell, A.N., Reardon, T., Retnanestri, M., Ruben, R., Struebi, P., Swinnen, J., Touesnard, M. A., Weinberger, K., Keatinge, J.D.H., Milstein, M.B. and Yang, R.Y. (2011). Research Principles for Developing Country Food Value Chains. *Science* 332 (6034): 1154-1155.

Kalwij, A.S. (2000). The effects of female employment status on the presence and number of children. *Journal of Population Economics* 13: 221-239.

Maertens, M. (2009). Horticulture exports, agro-industrialization, and farm-nonfarm linkages with the smallholder farm sector: evidence from Senegal. *Agricultural Economics* 40: 219-229.

Maertens, M., and Swinnen, J.F.M. (2009). Trade, Standards and Poverty: the Case of Vegetable Exports from Senegal. *World Development* 37 (1): 161-78.

Maertens, M., Colen, L. and Swinnen, J. (2011). Globalization and poverty in Senegal: a worst case scenario? *European Review of Agricultural Economics 38* (1): 31-54.

Maertens, M., Minten, B. and Swinnen, J. (2012). Modern Food Supply Chains and Development: Evidence from Horticulture Export Sectors in Sub-Saharan Africa. *Development Policy Review* 30 (4):473-497.

Maertens, M. and Swinnen, J. (2012). Gender and Modern Supply Chains in Developing Countries. *Journal of Development Studies* 48(10): 1412-1430.

Maertens, M. and Verhofstadt, E. (2013). Horticultural exports, female wage employment and primary school enrolment: Theory and evidence from Senegal. *Food Policy* 43: 118-131.

Neven, D., Odera, M.M., Reardon, T. and Wang, H. (2009). Kenyan Supermarkets, Emerging Middle-Class Horticultural Farmers, and Employment Impacts on the Poor. *World Development* 37 (11):1802-1811.

Osili, U.A. and Long, B.T. (2008). Does female schooling reduce fertility? Evidence from Nigeria. *Journal of Development Economics* 87: 57-75.

Rao, E.J.O. and Qaim, M. (2013). Supermarkets and agricultural labor demand in Kenya: A gendered perspective. *Food Policy* 38:165-176.

République du Sénégal (2012). Plan d'action national de Planification Famiale 2012-2015. Report.

Stock, J.H., Wright, J.H. and Yogo, M. (2002). A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments. *Journal of Business and Economic Statistics* 20 (4): 518-529.

Swinnen, J.F.M. (ed.) (2007). *Global supply chains: Standards and the poor.* Oxford: CABI Publishing.

Terza, J.V., Basu, A., and Rathouz, P.J. (2008). Two-stage residual inclusion estimation: Addressing endogeneity in health econometric modelling. *Journal of Health Economics* 27: 531-543.

UNICEF (2012). Senegal: Maternal, Newborn and Child Survival. Report.

Upadhay, U.D. and Karasek, D. (2010). Women's Empowerment and Achievement of Desired Fertility in Sub-Saharan Africa. Demographic and Health Research Working Paper, 80. ICF Macro, Calverton, MD.

Table A 1. Estimation of the impact on fertility rates by using a Difference-in-Differences estimator. ***Source*****: own estimations from survey data.**

	OLS		OLS with PSM		FE with PSM	
Year	0.581	***	0.582	***	1.407	***
	(0.057)		(0.058)		(0.069)	
Wage employment	-0.114	**	-0.113	**		
	(0.052)		(0.052)			
Employed * Year	-0.291	**	-0.291	**	-0.361	***
	(0.122)		(0.122)		(0.137)	
Age	0.070	***	0.069	***		
	(0.006)		(0.006)			
Literacy	-0.249	***	-0.249	***		
	(0.053)		(0.053)			
Single	-0.503	***	-0.508	***	0.425	***
	(0.063)		(0.064)		(0.120)	
Religion (1=christian)	-0.291	**	-0.291	**		
	(0.138)		(0.138)			
Ethnicity (1=Wolof)	-0.100		-0.102			
	(0.080)		(0.080)			
Ethnicity (1=Pular)	0.029		0.032			
	(0.085)		(0.085)			
Land owned (ha)	-0.001		0.000		-0.009	
	(0.003)		(0.003)		(0.015)	
Distance to concrete road (km)	0.013		0.014			
	(0.010)		(0.010)			
Constant	-0.697	***	-0.690	***	-0.148	
	(0.152)		(0.153)		(0.097)	
Number of observations	1994		1970		1970	
R-squared	0.378		0.378		0.355	

Significant effects are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Table A 2. Estimation of the impact on fertility rates by using a Poisson model, a Poisson model with village fixed effects and a Two-Stage Residual Inclusion. *Source*: own estimations from survey data.

	Poisson		Village FE		2SRI	
Wage employment	-0.257	**	-0.215	*	-0.262	
	(0.109)		(0.125)		(0.553)	
Age	0.469	***	0.469	***	0.470	***
	(0.075)		(0.078)		(0.085)	
Age²	-0.007	***	-0.007	***	-0.007	***
	(0.001)		(0.001)		(0.001)	
Literacy	-0.253	**	-0.243	**	-0.253	**
	(0.102)		(0.107)		(0.102)	
Single	-1.556	***	-1.526	***	-1.556	***
	(0.292)		(0.281)		(0.302)	
Number of children in 2005	0.208	***	0.179	***	0.208	***
	(0.056)		(0.066)		(0.063)	
Wife of HH head	0.981	***	1.023	***	0.980	***
	(0.135)		(0.139)		(0.131)	
(Grand)daughter of HH head	-0.887	***	-0.877	***	-0.886	***
	(0.196)		(0.194)		(0.197)	
Religion (1=christian)	-0.63	**	-0.652	*	-0.630	*
	(0.295)		(0.351)		(0.343)	
Ethnicity (1=Wolof)	-0.081		-0.055		-0.081	
	(0.126)		(0.240)		(0.161)	
Ethnicity (1=Pular)	0.001		-0.193		0.000	
	(0.133)		(0.245)		(0.155)	
Gender HH head (1=female)	0.353	***	0.369	**	0.353	***
	(0.130)		(0.154)		(0.137)	
Age HH head	0.012	***	0.011	**	0.012	***
	(0.004)		(0.005)		(0.004)	
Literacy HH head	-0.129		-0.117		-0.129	
	(0.094)		(0.096)		(0.099)	
Land owned (ha)	-0.003		-0.008		-0.003	
	(0.005)		(0.007)		(0.006)	
Livestock units	0.000		0.000		0.000	
	(0.001)		(0.001)		(0.001)	
Poor household (MPI>33)	0.190	**	0.191	**	0.190	**
	(0.083)		(0.089)		(0.084)	
Female organisation in village	-0.009				-0.008	
	(0.099)				(0.119)	
Multiple ethnicities in village	0.059				0.058	
	(0.115)				(0.111)	
Distance to concrete road (km)	0.006				0.006	
	(0.017)				(0.018)	
Share of girls enrolled in school	0.124				0.123	
	(0.294)				(0.296)	

Table A 2 (*continued*). Estimation of the impact on fertility rates by using a Poisson model, a Poisson model with village fixed effects and a Two-Stage Residual Inclusion. *Source*: own estimations from survey data.

	Poisson	Village FE	2SRI
Residuals			0.005
			(0.571)
Number of observations	997	997	997
Log Likelihood	-1150.77	-1130.41	-1150.77
Chi²	1201.73	1321.49	1169.64
Prob > Chi²	0	0	0
Pseudo R²	0.39	0.41	0.39

Significant effects are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01.

Table A 3. OLS estimation of first stage of 2SRI. *Source*: own estimations from survey data.

	Coefficient	Standard error	
Age	0.051	(0.018)	***
Age²	-0.001	(0.000)	**
Literacy	0.000	(0.027)	
Single	0.069	(0.033)	**
Number of children in 2005	0.017	(0.033)	
Wife of HH head	-0.051	(0.043)	
(Grand)daughter of HH head	0.087	(0.031)	***
Religion (1=christian)	-0.067	(0.077)	
Ethnicity (1=Wolof)	-0.078	(0.044)	*
Ethnicity (1=Pular)	-0.033	(0.048)	
Gender HH head (1=female)	0.056	(0.039)	
Age HH head	-0.001	(0.001)	
Literacy HH head	0.042	(0.030)	
Land owned (ha)	0.001	(0.002)	
Livestock units	0.000	(0.000)	
Poor household (MPI>33)	0.025	(0.025)	
Female organisation in village	0.069	(0.030)	**
Multiple ethnicities in village	-0.117	(0.032)	***
Distance to concrete road (km)	-0.010	(0.005)	**
Share of girls enrolled in school	0.059	(0.095)	
Distance to company (km)	-0.004	(0.001)	***
Constant	-0.557	(0.269)	**

Significant effects are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01.